sometimes than at others. The further it deviates from it the greater becomes the difference between the length of winter and summer, and the difference may even amount to more than thirty days every year. The length of winter and summer varies therefore in the course of 10,500 years, and the difference increases the more the earth's orbit deviates from the circular. During the 10,500 years in which the winter is longer than the summer there will be several thousand more winter days than summer ones, and in the second half-cycle there will be as many thousand less. Even at present, when the orbit deviates but little from the circular, the excess of winter or summer days for each half-cycle is more than 50,000, and when the deviation is greatest it amounts to nearly 220,000 days, or some 600 years.

As the cooling of the continents contributes to preserve the low atmospherical pressure over the oceans, and thus directs the prevailing winds and currents at sea, the winds thus directed, as, for instance, the south-west winds of the Atlantic, must be stronger in winter than in summer. *And this is indeed the case.* The weather conditions differ in summer and winter. Of course south-westerly winds blow predominantly in the North Atlantic and West Europe all the year, *but they predominate more in the winter.* According to Prof. Mohn, their force in the North Atlantic is about three times as great in the winter as in the summer, and similar conditions prevail in the Pacific Ocean. In the southern temperate seas north-west winds, which correspond to south-west ones with us, are equally predominant when there is winter in that hemisphere. It will therefore be seen that the forces which promote the warm sea-currents in our latitude *are most active in the winter.* And the same is the case in the Southern Hemisphere, so that it must be said that the winter favours these currents, whether it falls when the sun is nearest, as with us, or when it is most distant, as in the Southern Hemisphere. From Prof. Zöppritz's studies of the currents it appears that the wind exercises an influence upon the strength of them even long after it has ceased to blow. The action of the winds is summed up through centuries, *and the total recorded in the sea-currents.*

As we know that the wind conditions vary at different seasons, and that the effect of the wind does not cease as soon as it is discontinued, but leaves traces in the sea-currents for a long time after; so that, in fact, the strength of the current is dependent on the average force of the wind during last great ages—it can hardly be a matter of indifference whether these thousands of days fall as a surplus to winter or summer in the 10,500 yearly half-cycle. When they fall in the winter, the south-west winds must be more predominant than others; and, correspondingly, when they fall to the summer, weaker. It seems, therefore, reasonable that the currents must increase or decrease as the equinoctial line moves round. When the winter falls in aphelion our warm currents will increase, and when the reverse is the case they will decrease. We should, therefore, now in the Northern Atlantic have a weaker current, and in North-Western Europe less rain and a greater difference between winter and summer heat, *and this is exactly what the theory demands.*

In regions with different weather conditions the case will be different. For instance, in the eastern part of North America north-west winds are more predominant in the winter and south-west ones in the summer. Winter, in aphelion, would here increase the north-west wind, and one might conclude that these parts under such conditions would perhaps thereby obtain a more severe climate, so that it seems evident that variations in the climate will not simultaneously move in the same direction everywhere in the Northern (or Southern) Hemisphere.

From calculations we have elsewhere demonstrated that the varying length of the season alone during the precession of the equinoxes will cause an increase or decrease in the force of the current of several per cent. of the total. And these figures are doubtless below the true ones, but space does not here permit of developing them. We may, therefore, with a high amount of probability conclude *that the precession of the equinoxes causes periodical variations of the climate which are great enough to explain all the facts on which the theory for these periodical variations is based.*

But the eccentricity of the earth's orbit changes so rapidly that in two consecutive half-cycles it is not as a rule the same. Therefore variations in the strength of sea-currents, and consequently also those in the climate in one half-cycle will not be quite balanced in the next, and it might even be possible that greater and more lasting variations of the climate might be caused by the same agencies.

A. Blytt

The University, Christiania

VEGETABLE PRODUCTS AT THE COLONIAL AND INDIAN EXHIBITION

In passing through the various courts of the Colonial and Indian Exhibition the prevailing natural resources of each colony are apparent even to the most unobservant, for while the riches of some countries are to be found chiefly in their vegetable products, the wealth of another is in its mineral resources, and of another in its animals.

Regarding the vegetable products, as might be supposed, some of the most interesting objects from a scientific point of view are those which have the least attraction for the general public, such, for instance, as the large and varied collection from the Straits Settlements, or the interesting exhibits from British North Borneo. Amongst the exhibits from the former possessions are various samples of damar, the botanical origin of which is but imperfectly known; thus, for instance, are specimens of damar sesa, a fossil resin from Larut, Perak, damar meta kuching, or cat's-eye damar, damar renkong, and others. Another fossil resin new to us is called incense or gum Benjamin. Under the name of buah saga are shown some seeds of an *Adenanthera*, probably those of *A. pavonina*, a seed of which is the unit in the Malay jeweller's weight, equal to 4·33 grains troy. The seeds are also eaten by the natives. The tree is found in India, China, and the Philippines. In India the wood, which is of a red colour, hard, and close-grained, is known as red sandal-wood, and is used as a red dye, as well as for cabinet-making and building purposes. On account of their bright red colour the seeds are used as necklaces. Naturally in countries where the bamboo is abundant we should expect to find numerous illustrations of its uses, and various articles of domestic utility, as well as for other applications besides that of ornament, are shown, some of which are very ingenious, such as a trap called grôgoh, used for catching river fish; it is somewhat of the shape of an eel-pot, and the body of the trap is made of a single piece of bamboo-stem of about 2 inches diameter, and from 14 to 18 inches long. It is split longitudinally for the greater part of its length into fine strips, these are distended to a wide mouth at the top some 6 or 8 inches diameter, tapering to the point from which they spring, where they form the natural stem. By the addition of other fine strips of bamboo fastened round at short intervals a complete funnel-shaped basket or eel-pot is made, the lower or tubular end of which is formed by the hollow bamboo-stem. The ready way in which the natives adapt natural productions is seen in a very simple spinning-top, which is composed of a flattened acorn of the type of *Quercus placentaria*, through the centre of which a piece of wood is driven. In this division also are some very varied sets of betel-chewing appliances as used by the Malays, including the scissor-like implements used for cutting the betel-nuts; many of these sets are in deftly-worked brass, while others are in more costly metals.

The collection from British North Borneo has many interesting exhibits, notably some remarkably fine specimens of gutta-percha and india-rubber a magnificent plank of the Sumatra or Bornean camphor-tree (*Dryobalanops aromatica*), the crystallised camphor of which is found deposited in cracks and fissures in the wood, occurring sometimes in very large masses; it is largely used by the Chinese, who prefer it to the ordinary camphor of commerce which is produced in their own country. Bornean tobacco is also a prominent object here, and is exhibited both in bundles of cured leaves as well as in cut form. A favourable report has been obtained of this tobacco, and it has been valued above the average of Sumatra tobacco, for which indeed it has been mistaken even by experts.

In the Hong Kong Court the varied uses to which bamboos and rattans are put are largely represented; the difference, however, in the character of the work to which the stems of these two classes of plants are applied is manifest at a glance, for while the rigid stems of the *Bambusas* are used for the rougher or coarser work, those of the pliable species of *Calamus* form the materials from which the finer basket-work, screens, &c., are manipulated. Various examples of the baker's art in the form of biscuits are shown by the Hong Kong and China Bakery Company, Limited, and it is stated, as an illustration of the capabilities of this bakery, that it can turn out 15,000 pounds of ship biscuits or 10,000 pounds of bread per day.

The British Guiana collection almost adjoins that of Hong Kong. Here, as might be expected from the extent of the forests of the colony and the abundance of large hard-wooded trees, timber takes a prominent place, and some magnificent specimens of the best known woods, such as mora (*Dimorphandra Mora*), greenheart (*Nectandra Rodiœi*), wallaba (*Eperua falcata*), and other well-known and useful timbers are exhibited. The heartwood of these timbers is described as "almost everlasting, the beams of old houses being good for over a hundred years in the most unfavourable circumstances of a tropical climate infested with wood-ants and other vermin." Specimens of tibiserie fibre and hammocks made from it are here exhibited. This fibre, which is obtained from the young leaves of the Eta palm (*Mauritia flexuosa*), is of wonderful strength and tenacity, from it the natives make their strongest and most durable cords and hammocks. It is very easily obtained and in any quantity, and if better known in Europe might become a valuable article of commerce. A fine collection of medicinal and tanning barks are here shown, but unfortunately, like the woods from this colony, comparatively few have other than native names. In the catalogue of exhibits it is stated that "the medicinal barks are very varied; a few are well known, but the majority, having never received the attention of chemists or physicians, are as yet untried, but may possibly be found worthy a place in the Materia Medica. Fair quantities are exhibited, and will be distributed to qualified persons who will undertake to report on their qualities. Most of them are common in the colony, and can be easily procured."

It is scarcely correct to say that the medicinal barks of British Guiana have never received the attention of chemists or physicians, for at the close of the International Exhibition of 1862 some twenty different medicinal barks of the colony were experimented upon and their effects tried in various cases by Mr. Charles Hunter, who was some time House Surgeon to St. George's Hospital. The results of his experiments were embodied in a pamphlet, and published at the time by Messrs. Churchill and Sons of New Burlington Street, but we never heard that any of them came into use in this country, and it is to be hoped that better results may be obtained from the present collections.

JOHN R. JACKSON

WHAT IS A GLACIER?[1]

GLACIERS have become so well known from the graphic descriptions of Carpenter, Forbes, Agassiz, Tyndall, and other explorers, that it seems unnecessary at this time to do more than call attention to a few of their more characteristic features by way of an introduction to what I have written concerning those now existing in the United States.

The formation of glaciers in any region depends primarily on the fact that the amount of snow precipitated during a term of years exceeds the amount dissipated by melting and evaporation. In this manner snow-banks of broad extent are formed, the lower portions of which become compacted into ice. The change from snow to ice is known to result from pressure, and as ice is mobile under pressure, either by reason of its inherent plasticity or as a result of regelation, the weight of this mass tends to change its form, and it thus acquires motion, which takes the direction of least resistance.

The essential characteristic of glaciers seems to be that they result from the consolidation of snow in regions of secular accumulation, *i.e.* above the snow-line, and flow to regions of dissipation, *i.e.* below the snow-line. From these primary conditions result a multitude of secondary phenomena.

For convenience of reference we will divide glaciers into *alpine* and *continental;* not that the two classes are always distinct and separable, but for the reason that typical examples of each are well characterised and capable of specific description. Variations occur in each class which may suggest minor subdivisions.

The glaciers with which we are most familiar belong to the class that have their archetype in the mountains of Switzerland, and occur about high peaks, usually in amphitheatres or *cirques* at the heads of high-grade valleys. The snow that accumulates on high mountains, especially in temperate latitudes, is frequently not completely melted during the summer, and thus tends to increase indefinitely. The *névé* of a glacier is such a snow-field. The gorge or valley leading from every alpine amphitheatre furnishes an avenue of escape for the consolidated *névé*-snow, which is forced out through the opening, and flows for a greater or less distance as a stream of ice. Such in brief is the genesis of an alpine glacier. Every glacier of this class is divided into a *névé*, or snow-region, above, and an icy portion below. The line of demarcation is the *snow-line*. As compact ice occurs also beneath the *névé* from which it is formed, this division of a glacier into two portions applies only to the surface. The division line, moreover, shifts with the seasons; at times, perhaps for many years together, the true glacier ice may be concealed by a snowy covering. The *névé* is composed of granular snow, white or grayish-white in colour, and comparatively free from dirt and stones; below the snow-line the glacier is formed of both porous and compact ice, and is usually concealed more or less completely with rock-debris. From a distance these two divisions are frequently distinctly shown by contrast in colour. The stones and dirt that fall on the *névé* sink more or less deeply into the snow and become buried beneath the next addition, and as the *névé* becomes consolidated and acquires glacial motion, this debris is carried along in its mass. But the region below the *névé* being one in which loss exceeds supply, the snow and ice are melted, and the foreign bodies formerly held in the mass become concentrated at the surface, and are then carried along as moraines. Thus in the *névé* region the tendency is to bury foreign objects, and in the glacier proper to concentrate them at the surface.

All the debris carried by glaciers may be designated in general terms as *morainal* material, but when arranged

[1] From Memoir on "Existing Glaciers of the United States," by Israel C. Russell. Reprinted from the Fifth Annual Report of the Director of the U.S. Geological Survey.